



NASA STTR 2009 Phase I Solicitation

T7 Launch Site Technologies

With the advent of the Constellation program new inspection requirements will be required at the launch site and one area of specific interest is the examination of non-metallic materials, such as foam, cork, Avcoat, and others. When these materials are applied to the spacecraft there is a possibility that voids will be created, either due to missing material or to missing adhesive. Also, some materials may be applied in a non-uniform manner or become non-uniform after exposure to the environment, for example from water absorption. A capability that can be used at the launch site to examine these materials and produce a 3D image highlighting non-uniformities will be beneficial to the new program. In addition, access is usually limited to one side of the material since it is being applied to a spacecraft or fuel tank, so the imaging technique will need to operate in a reflective rather than a transmissive manner.

Subtopics

T7.01 One-Sided 3D Imaging of Non-Uniformities in Non-Metallic Space Flight Materials

Lead Center: KSC

In the Space Shuttle program as well as the Constellation program, limited assembly occurs at the launch site. For example, most of the insulation on the Space Shuttle's External Tank is applied during construction, but a few access areas are left bare and must be coated after the External Tank is attached to the Solid Rocket Boosters and Orbiter. Since this insulation is often applied in layers it is possible that voids may be formed, necessitating an evaluation method to ensure integrity. One approach, a backscatter x-ray technique, was recently demonstrated that allows one-sided 2D imaging of defects and voids in the Space Shuttle External Tank's sprayed on foam insulation (SOFI) http://sxi.nre.ufl.edu/research/papers/SPIE50_6.pdf. This method works well for large thin acreage sheets, but for smaller, more complicated volumes a 3D imaging method would improve the location and subsequent repair of the foam.

Recently x-ray backscatter was also demonstrated as a technique for locating voids in the adhesive used to attach sections of a Phenolic Impregnated Carbon Ablator (PICA) heat-shield to each other and to a capsule. The concern was in examining the workmanship of this assembly after completion to ensure that adequate adhesive had been used. The x-ray backscatter technique worked well for this application, but required imaging at relatively steep angles in order to see the various planes of adhesive. A 3-D capability would improve the performance of this technique and help determine where voids or imperfections were located. NASA has now selected Avcoat as the heat-shield material for the Orion Spacecraft and similar inspections will be required for it.

These two examples highlight the need for a system that can generate 3D images of non-metallic materials when access is limited to one side of the material. In many cases contact with the material is allowed opening the range of possible solutions to include ultrasonic and capacitive, in addition to the noncontact x-ray approach mentioned above and TeraHertz or Millimeter Wave (MMW) systems, as well as others. The primary technical advance being sought here is to extend methods that normally supply a 2D projected image through a sheet of material, to a 3D image of a more complicated volume, such as foam sprayed over a strut. It would be advantageous if the proposed method were potentially portable, allowing it to be brought to the spacecraft; rugged, allowing it to be handled in the field; and inexpensive, allowing several to be available for multiple applications.